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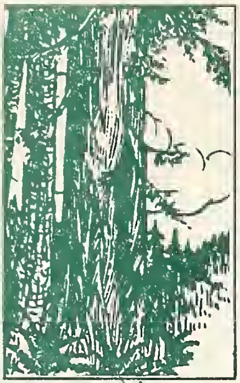

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POSSIBLE MEANS OF REDUCING MOUNTAIN PINE BEETLE ATTACKS IN YOUNG SUGAR PINE

V. A. Clements[1]

The mountain pine beetle (Dendroctonus monticolae Hopk.) is well known as a periodic threat to mature Western white pine, lodgepole pine and sugar pine, and occasionally to young ponderosa pine. A recent outbreak on the Sierra National Forest provides the first recorded case of heavy killing of young sugar pine.[2]

The Sierra outbreak is in the Miami Creek, Lewis Creek, and Big Creek drainages just south of Yosemite National Park. It has been estimated that in 3 or 4 years before May 1952, at least 10,000 young sugar pine and ponderosa pine were killed in this area.

The implications of this epidemic are serious. Such outbreaks must be prevented or greatly reduced in intensity if sugar pine is to be maintained as a commercial timber tree. Direct control on the Sierra area has reduced epidemic losses by 60 to 70 percent,[3] but is only a temporary expedient. Too expensive to be used as a regular management practice, direct control removes infested trees but does not alleviate conditions that tend to favor epidemics. The purpose of this paper is to report briefly the results of a study aimed at learning something about stand conditions that lead to mountain pine beetle epidemics, and to suggest possible remedial measures.

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[1] This study was made possible by the help of G. R. Struble of the Berkeley Forest Insect Laboratory, U. S. Department of Agriculture, and members of the staff of the Sierra National Forest, particularly C. E. Risbrudt, K. C. McLees, and the members of the forest's sugar pine delineation crews who collected the plot data. Their help is gratefully acknowledged.

[2] Struble, George R. 1952. Current developments, valuable second-growth sugar pine stands threatened. Forest Insect Laboratory. Berkeley, California.

[3] Hall, R. C., and M. M. Furniss. 1952. Forest Insect Conditions Miami Creek, Lewis Creek, and Big Creek drainages, Sierra National Forest. Office Report. Forest Insect Laboratory, Berkeley, California.

* MAINTAINED AT BERKELEY, CALIFORNIA, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA.

The Data

The basic data for this study were obtained from 70 sample plots, 53 from the Miami Creek basin and 17 in the Lewis Creek drainage. Records were made on two types of plots: (1) "Stand plots," 1 x 1 chain in size (0.1) acre, spaced 5 chains apart on lines through areas known to be in the infested zone; (2) "Kill plots," to sample stands that had been subject to heavy kill, thereby supplementing information from the systematic stand plots. The kill plots varied in size to enclose groups of dead trees, ranging from 1 x 1 chain to 2 x 2 chains (0.4 acre). Kill plots were placed wherever groups were observed while setting out stand plots. The two types often coincided.

Information collected on both types of plots was:

1. All live trees of any species 2 inches d.b.h. and over were tallied by 2-inch classes. Sugar pine and ponderosa pine were further recorded by crown classes.

2. Insect killed pines were tallied by species, 2-inch d.b.h. classes, and two crown-class groups--dominant and codominant, and intermediate and suppressed. This grouping of crown classes was used since it was not possible to determine the exact crown class of dead trees, particularly of those dead 2 or 3 years.

3. Since the plots were tallied in July 1952 after the first direct control operation, the dead pines were further subdivided into two classes: (a) trees killed by the 1951 infestation (which had been treated) and any successfully attacked by 1952 broods of beetles, and (b) trees killed before the 1951 infestation. This rough classification by period of kill is the only measure of development and changes during the epidemic.

The Forest

The stands in this area are some of the finest, high site quality young sugar pine forests in California. The species composition varies considerably, but a large part of the young stands are mixed-conifer types with substantial proportions of sugar and ponderosa pines. By numbers of trees, the original stand on the plots averaged 30 percent sugar pine, 7 percent ponderosa pine, 25 percent white fir, and 38 percent incense cedar (table 1). The total number of trees, 658 per acre, indicates a well stocked stand. If stocking is rated by stand density index4/, that is, the number of trees in relation to average d.b.h. of the stand, this stand has a stand density index of 390. Reineke indicates 4/ that for small heavily stocked plots, a stand density index of 800 is about the maximum stocking for mixed-conifer stands. On that basis these Sierra National Forest stands would be about 50 percent stocked, which experience indicates is an excellent average stocking for a large area.

4/ Reineke, L. R. 1933. Perfecting a stand-density index. Jour. Agric. Res. 46: 627-638.

Table 1.- Live, dead, and original number of pines and number of white fir and incense cedar, by d.b.h. groups. Average for 70 plots.

D.b.h. group, in.	Sugar Pine			Ponderosa Pine			White Fir	Incense Cedar	All species	
	Orig. stand	Live	Dead	Orig. stand	Live	Dead			Orig. stand	Remain. stand
	. . . . . . Number of trees per acre									
2 - 10	145.2	48.2	97.0	33.9	12.6	21.3	136.6	229.8	545.5	427.2
12 - 16	32.9	14.9	18.0	9.0	6.9	2.1	18.6	10.5	71.0	50.9
18 - 22	11.2	7.6	3.6	2.9	2.8	0.1	7.1	3.2	24.4	20.7
24 - 28	4.7	3.2	1.5	1.1	0.9	0.2	3.6	2.0	11.4	9.7
30 - 34	1.0	0.9	0.1	0.8	0.8	-	1.4	1.1	4.3	4.2
26 and over	0.1	0.1	-	0.1	0.1	-	-	1.6	1.8	1.8
Total	195.1	74.9	120.2	47.8	24.1	23.7	167.3	248.2	658.4	514.5

The stands in the study area developed from advance reproduction and natural regeneration after logging as much as 50 years ago. There is an overstory of mature and overmature trees left by the early loggers on much of the area. Age of the young pine in these stands ranges from 40 to 70 years.

What Happened to the Forest

In the few years since 1949, when the mountain pine beetle began to show unusual activity in the stands, losses in sugar pine and ponderosa pine on the sample areas have been very heavy. Sixty-two percent of the sugar pines in the original stand have been killed, and 50 percent of the ponderosa pines (table 1). The net effect of these losses has been to reduce the pine component of these plots from 36.7 percent of the number of trees of all species to 19.2 percent in 1952. Losses outside the plots probably have been substantially less than on the plots, because the "kill plots" were deliberately placed in severely damaged areas.

Most of the insect losses were in the small diameter classes. Trees less than 12 inches d.b.h. made up 80 to 90 percent of the losses in sugar pine and ponderosa pine respectively. However, many of the dead trees were from the upper crown classes. The total number of pines killed on the plots was 1130, of which 348 were in the dominant and codominant group and 782 intermediate and suppressed. These losses represent 44 percent and 69 percent of the original numbers present in these crown class-groups.

Losses in Relation to Stand Characteristics

The plot data were used to study the relation between stand attributes and losses. Such factors as number of trees, number of pines, percent of the stand composed of pine, and several others were considered. Most of them showed no relation to insect losses. The results of a series of statistical analyses show that the following factors were not significantly related to the occurrence of insect losses:

1. Total number of trees per acre of all species.
2. Total number of pines per acre.
3. The number of pines expressed as percentage of the total number of trees.

Two characteristics, stand density index and crown class, both showed significant correlation with occurrence of insect attack. The greatest losses occurred where the stand density index was high. Stand density index is a more sensitive indicator of stocking than number of trees because it evaluates density of stocking by number of trees in relation to the average diameter of the stand. The number of intermediate and suppressed pines is important since the plot data show that the greatest kill in the early stages of the epidemic is in the understory trees. When the data are divided at the 1951 infestation, 77 percent of the trees killed before the 1951 attacks were intermediate and suppressed, in contrast to 47 percent of the trees killed by the 1951 and later attacks. Apparently the mountain beetles attacked the weak understory trees first, and as the infestation gained in intensity the beetles were able to attack and kill a greater number of the more vigorous overstory trees.

Suggested Stand Treatments

The results of this study point to two stand conditions that seem to indicate susceptibility of young sugar pine stands to attack by the mountain pine beetle. These conditions are: (1) high density of stocking as reflected by stand density index, and (2) the presence of understory (intermediate and suppressed) pine trees that seem to be attacked first.

The practical implications are that the ability of stands to resist attack may be improved either by reducing stand density or by removing trees which are especially susceptible. Reducing the stand density would, of course, be an indirect method of improving the vigor of the remaining trees. It is based on the observation that if released from competitors, trees which are not too badly suppressed or stagnated often improve in growth rate and general vigor. A cutting designed to reduce stand density might take the form of a commercial harvest that would remove larger trees of sawtimber size. These would include the overmature and mature trees left by the early logging, and younger white fir and incense cedar of merchantable size.

From the analysis of the stand data it has been determined that a considerable volume of merchantable material can be cut. If 24 inches d.b.h. is the lower limit of cutting, at least 10,000 board feet per acre is available. Of this volume at least 4,000 board feet is pine. A cutting of this degree should still leave an average of 10,000 to 12,000 board feet per acre of young pine and 4,000 to 5,000 feet of fir and cedar. It should be noted that the loss in pine in the recent outbreak was about 4,000 board feet per acre or 25 percent of the total pine volume.

Removal of the more susceptible trees, the second alternative suggested by the study, would be a more direct method. It would require a cash outlay that could not be recovered because the smaller susceptible trees have little or no market value at present. In addition to eliminating the trees which are more likely to nourish an insect attack during the population build-up stage, this alternative method would also serve to reduce stand density somewhat.

Although we cannot be certain just how effective either of the suggested methods would be in lessening tne danger of mountain pine beetle attack, they both appear to offer considerable promise. Probably, the best recommendation which can be offered at present is a combination of both kinds of cutting. A commercial cutting should more than pay its way while resulting in a substantial reduction in stand density, and thus pay for all or part of the expense of eliminating many of the small, more susceptible trees.